USE OF A BLUE FLAME BURNER

The invention is directed to an improved use of a blue flame burner.

Conventional designs of oil burner assemblies for home heating fuel oils employ a traditional fuel/air mixing process in which the evaporation and combustion of the fuel oil take place simultaneously. In one form of oil burner assembly for home heating fuel oils the fuel oil is sprayed as a hollow cone and air is weakly swirled along a path which is parallel to the axis of a burner blast tube and which passes into the hollow cone so that the trajectories of the fuel oil droplets cross the air flow streamlines. This leads to a rapid evaporation giving fuel oil rich regions, which in turn ignite under local sub-stoichiometric conditions producing soot, and results in air pollution as well as well as a waste of a fossil fuel.

The general pattern of the flame of such an oil burner assembly is one of heterogeneity in terms of fuel concentrations; the pockets of fuel lean mixture give rise to high nitric oxide concentrations from both the fuel nitrogen and the atmospheric nitrogen, while the pockets of fuel rich mixture give rise to soot. The visible flame from such a system is yellow. The yellow colour is the visible radiation from the high temperature soot particles and this completely masks other visible radiations as far as the human eye is concerned. These soot particles result from unburnt carbon.

For complete combustion of the carbon, that is soot-free combustion, the step-wise combustion of carbon to

carbon dioxide via the intermediate carbon monoxide stage gives rise to a visible radiation in the blue region of the light spectrum. When this occurs the blue radiation becomes visible in a soot-free or low-luminosity flame, and oil burners for such soot-free flames are known as blue flame burners. US-A-3545902 discloses a blue flame burner.

Blue flame burners are known to have low NO_x emissions. Nevertheless there is a need for even lower NO_x emissions. Especially the NO_x emissions when petroleum derived fuels such as gas oil or kerosene is used are sometimes too high.

The object of the present invention is a use of a blue flame burner wherein the emissions of NO_x is reduced as compared to the prior art situation.

This object is achieved by the following use. Use of a Fischer-Tropsch derived fuel in a blue flame burner.

Applicants have found that the low NO_x emissions of a blue flame burner can be even further reduced when a Fischer-Tropsch derived fuel is used. An even further advantage is that the carbon monoxide emission is reduced. A next advantage is that less odor during start and extinction of the blue flame burner has been observed when using this fuel. This is very advantageous, especially when such a burner is used in a domestic environment.

Without wishing to be bound by the following theory applicants believe that the lower NO_x emissions can be explained by the better evaporation properties of the Fischer-Tropsch derived fuel. The resulting quicker evaporation of the liquid fuel droplets result in a lower local temperatures in the flame, which in turn results in a reduced thermal NO_x formation.

The blue flame burner is characterized in that the combustion of the hydrocarbon fuel to carbon dioxide is performed such that part of the flue gas is recycled to the flame and more suitably to the nozzle of the burner. Recycling part of the flue gas externally of the burner may effect such recirculation of the flue gas. Alternatively recycling may be achieved by swirling the combustible mixture of fuel and oxygen containing gas wherein at the axis of the swirling flame some recirculation of flue gas takes place. Figure 1 shows a schematic representation of a blue flame burner with an external recirculation of flue gas.

Figure 1 shows a blue flame burner 1 having means 2 to supply a liquid fuel and means 3 to supply an oxygen containing gas. The oxygen containing gas is usually air. Means 4 to mix the fuel and air to form a combustible mixture which is fed to pre-combustion space 5, which is formed by the interior of tubular part 6. Tubular part 6 is placed co-axial in a larger tubular part 7, which forms the final combustion space 8. Flue gas is discharged via outlet opening 9 into the outlet space 10. Openings 11 in tubular part 7 serve as means to recycle part of the flue gas to the final combustion space 8. Openings 12 in tubular part 6 serve as means to recycle part of the gas present in the final combustion space 8 to the pre-combustion space 5.

The operating conditions of the blue flame burner may be the same as the operating conditions used for the state of the art fuels. The proportion of air in excess of that required for stoichiometric combustion is known as the excess air ratio or "lambda", which is defined as the ratio of total air available for combustion to that required to burn all of the fuel. Preferably the lambda

is between 1 and 2 and more preferably between 1 and 1.6. Applicants found that by using a Fischer-Tropsch derived fuel a very low lambda of between 1.05 and 1.2 could be applied without large emissions of carbon monoxide as would be the case when Industrial Gas Oil would be used.

The blue flame burner using the Fischer-Tropsch fuels is preferably applied for domestic heating, wherein the heat of combustion is used to heat water by indirect heat exchange in so-called boilers. The heated water may be used to warm up the house or consumed in for example showers and the like. More preferably the blue-flame burner is used in (domestic) application wherein more than 3 starts of the burner per hour takes place. The use of the present invention is especially suited for such applications because low hydrocarbon and carbon monoxide emissions have been found at the start of the burner running on the Fischer-Tropsch derived fuel.

The blue flame burner using the Fischer-Tropsch fuels may advantageously be further used for direct heating of large spaces. Such applications are characterized in that the flue gasses are directly supplied to said space to heat up said space. Spaces such a tents and halls are often heated up with such an apparatus. Normally gaseous fuels for example natural gas, LPG and the like, are used for this application because the associated flue gasses can be safely supplied to said space. A disadvantage of the use of gaseous fuels is however that handling of the pressurized gas containers and combustion equipment requires professional skills in order to operate such an apparatus safely. By using a Fischer-Tropsch derived liquid fuel a comparable flue gas is obtained in the blue flame burner as when a gaseous fuel is used. Thus a method is provided wherein a liquid fuel can be applied

for direct heating of spaces. The application of the liquid Fischer-Tropsch derived fuel makes the use of the apparatus for direct heating much more simple and safe.

Blue flame burners are often provided with a flame detector. Examples of suitable detectors are the UV sensors and IR sensors. A more preferred detector is the so-called ionisation sensor. An ionisation sensor is suitable to monitor burners with intermittent operation as well as continuous operation. The principle of operation of the ionisation flame monitor is based on the rectifying effect of a flame. If a flame is present, a current flows between the burner an the ionisation electrode. This ionisation current is evaluated by the flame monitor to determine if a flame is present. In some prior art applications ionisation sensors could not be used in combination with a liquid fuel because deposits in the sensor led to false currents in the sensor. Because use of the Fischer-Tropsch derived fuel results in less deposits ionisation sensors can be applied. This is an advantage because these sensors are more readily available than the IR or UV sensors.

The Fischer-Tropsch derived fuel will comprise a Fischer-Tropsch product, which may be any fraction of the middle distillate fuel range, which can be isolated from the (hydrocracked) Fischer-Tropsch synthesis product. Typical fractions will boil in the naphtha, kerosene or gas oil range. Preferably a Fischer-Tropsch product in the kerosene or gas oil range is used because these fractions are easier to handle in for example domestic environments. Such products will suitably comprise a fraction larger than 90 wt% which boils between 160 and 400 °C, preferably to about 370 °C. Examples of Fischer-Tropsch derived kerosene and gas oils are

described in EP-A-583836, WO-A-9714768, WO-A-9714769, WO-A-011116, WO-A-011117, WO-A-0183406, WO-A-0183648, WO-A-0183647, WO-A-0183641, WO-A-0020535, WO-A-0020534, EP-A-1101813, US-A-5766274, US-A-5378348, US-A-5888376 and US-A-6204426.

The Fischer-Tropsch product will suitably contain more than 80 wt% and preferably more than 90 wt% iso and normal paraffins and less than 1 wt% aromatics, the balance being naphthenics compounds. The content of sulphur and nitrogen will be very low and normally below the detection limits for such compounds. This low content of these elements is due to the specific process wherein the Fischer-Tropsch reaction is performed. The content of sulphur will therefore be below 5 ppm and the content of nitrogen will be below 1 ppm. As a result of the low contents of aromatics and naphthenics compounds the density of the Fischer-Tropsch product will be lower than the conventional mineral derived fuels. The density will be between 0.65 and 0.8 g/cm^3 at 15 °C.

The fuel used in the process of the present invention may also comprise fuel fractions other than the Fischer-Tropsch derived product. Examples of such fractions may be the kerosene or gas oil fractions as obtained in traditional refinery processes, which upgrade crude petroleum feedstock to useful products. Preferred non-Fischer-Tropsch fuel components are the ultra low sulphur (e.g. less than 50 ppm sulphur) kerosene or diesel fractions, which are currently on the market. Optionally non-mineral oil based fuels, such as bio-fuels, may also be present in the fuel composition. The content of the Fischer-Tropsch derived product in the fuel will be preferably be above 40 wt%, more preferably above 60 wt% and most preferably above 80 wt%. It should

be understood that the content of such, currently less available, Fischer-Tropsch product will be optimised, wherein pricing of the total fuel will be balanced with the advantages of the present invention. For some applications fuels fully based on a Fischer-Tropsch product plus optionally some additives may be advantageously used.

The fuel may also comprise one or more of the following additives. Detergents, for example OMA 350 as obtained from Octel OY; stabilizers, for example Keropon ES 3500 as obtained from BASF Aktiengesellchaft, FOA 528A as obtained from OCTEL OY; metal-deactivators, for example IRGAMET 30 (as obtained from Speciality Chemicals Inc; (ashless) dispersants, for example as included in the FOA 528 A package as obtained from Octel OY; anti-oxidants; IRGANOX L57 as obtained from Speciality Chemicals Inc; cold flow improvers, for example Keroflux 3283 as obtained from BASF Aktiengesellschaft, R433 or R474 as obtained from Infineum UK Ltd; combustion improver, for example ferrocene, methylcyclopentadienyl-manganese-tricarbonyl (MMT); anti-corrosion: Additin RC 4801 as obtained from Rhein Chemie GmbH, Kerocorr 3232 as obtained from BASF, SARKOSYL 0 as obtained from Ciba; re-odorants, for example Compensol as obtained from Haarman & Reiner; biocides, for example GROTA MAR 71 as obtained from Schuelke & Mayr; lubricity enhancers, for example OLI 9000 as obtained from Octel; dehazers, for example T-9318 from Petrolite; antistatic agents, for example Stadis 450 from Octel; and foam reducers, for example TEGO 2079 from Goldschmidt.

The Fischer-Tropsch derived fuel is colourless and odourless. For safety reasons an odour marker, as for example applied in natural gas for domestic consumption,

may be present in the Fischer-Tropsch derived fuel. Also a colour marker may be present to distinguish the fuel from other non-Fischer-Tropsch derived fuels.

The total content of the additives may be suitably between 0 and 1 wt% and preferably below 0.5 wt%.

The invention will now be illustrated with the following non-limiting examples.

Example 1

To a blue flame burner of type Gulliver BLU BGI (Riello) as placed in a Vitola 200 Boiler (Viessmann Werke Gmbh&Co) a Fischer-Tropsch derived kerosene (Oil A), a Fischer-Tropsch gas oil (Oil B), an ultra low sulphur gas oil (Oil D) and a standard industrial gas oil (Oil C) having the properties as listed in Table 1 was fed at different lambda. The oils contained the same standard additive package.

Table 1

	Fischer-Tropsch kerosene (A)	Fischer-Tropsch gas oil (B)	Reference oil-1 (C)	Reference oil-2 (D)
Density (at 15 °C in kg/m^3)	734.8	785.2	854.3	846.3
Sulphur content (wt%)	0.0005	< 0.0005	0.142	0.061
Kinematic viscosity at 20 °C (mm^2/s)	1.246	6.444	3.842	4.621
Flash point (°C)	43	92	64	66

During the experiment the NO_x content was measured by chemoluminescence. In Figure 2 the NO_x emission relative to the energy is shown at different Lambda values for the fuels A-D. The energy in kWh is calculated from the amount of fuel fed to the burner and its caloric value. It is clear that the NO_x emissions are lower for the Fischer-Tropsch derived fuels as compared to when a normal gas oil or an ultra low sulphur gas oil is used.

The carbon monoxide emission was also measured. In Figure 3 the CO emission relative to the energy is presented for different values of lambda for oils A-D.